



# Three Energetic Pulsars Coincident with EGRET sources



UCSC Dec 11, 2001  
Vicky Kaspi



McGill



# Summary

- PSR J1420-6048 D'Amico et al., ApJ, 552, L45, 2001
- PSR J1837-0604 D'Amico et al., ApJ, 552, L45, 2001
- PSR J1016-5857 Camilo et al., ApJ, 557, L51, 2001

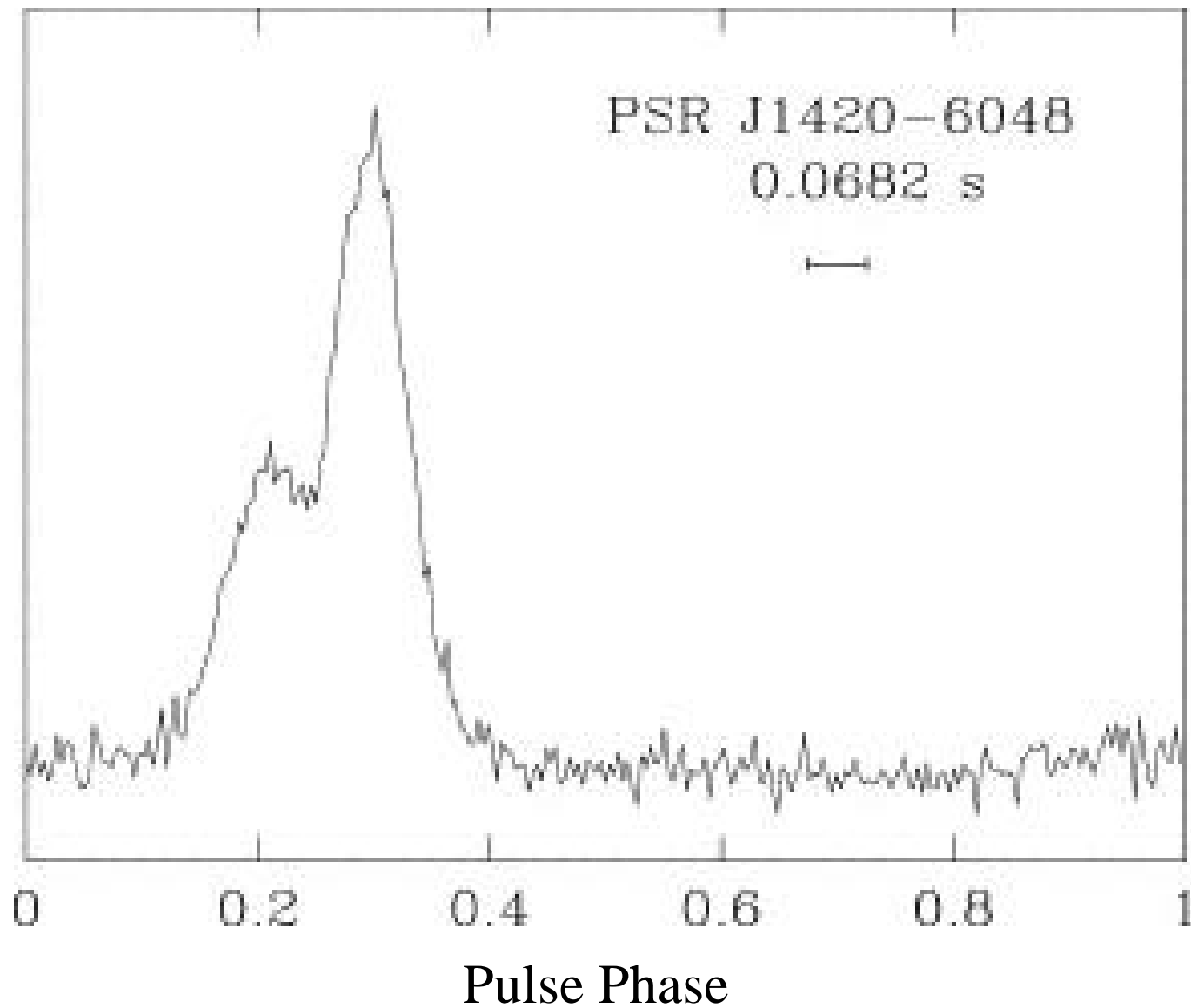
All are Parkes survey pulsars.

# PSR J1420-6048

- $P = 68 \text{ ms}$ ,  $dP/dt = 83\text{e-}15$
- characteristic age = 13 kyr
- $B = 2.4\text{e}12 \text{ G}$
- $dE/dt = 1\text{e}37 \text{ erg/s}$
- $DM = 360 \text{ pc/cm}^3$ ,  $d = 7.7 \text{ kpc}$
- flux density @ 1400 MHz = 0.9 mJy

D'Amico et al. 2001

# PSR J1420-6048

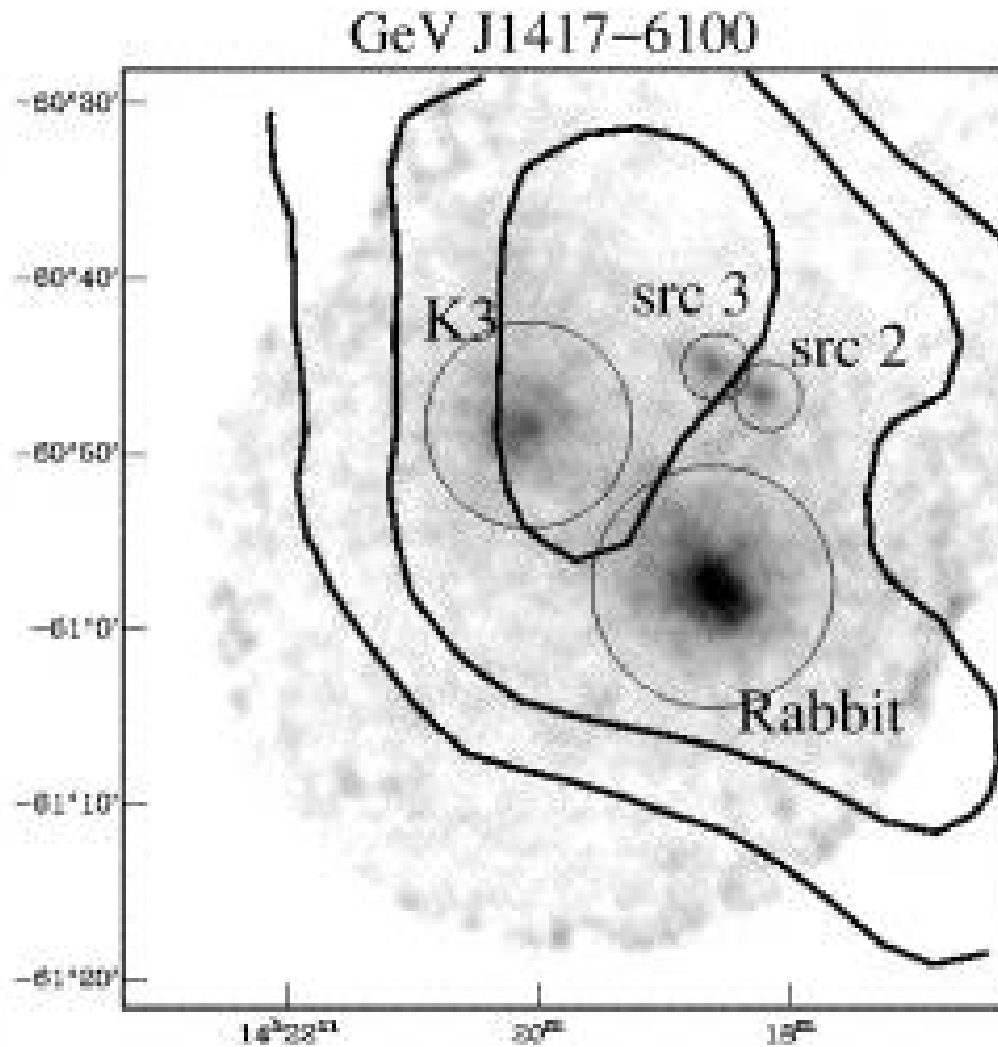


Average  
pulse at  
1400 MHz

## 3EG J1420-6038

- aka GEV 1417-6100
- PSR J1420-6048 is 10' from likeliest 3EG position
- 95% confidence region has radius  $\sim 19'$
- 100 MeV - 10 GeV photon index  $2.02 \pm 0.14$
- flux is  $(3.3 \pm 0.9) \times 10^{-10}$  erg/s/cm<sup>2</sup>
- for  $d=7.7$  kpc and beaming of 1 sr, gamma-ray efficiency is 2%
- EGRET source non-variable (McLaughlin et al. 96)

# ASCA 2-10 keV Image

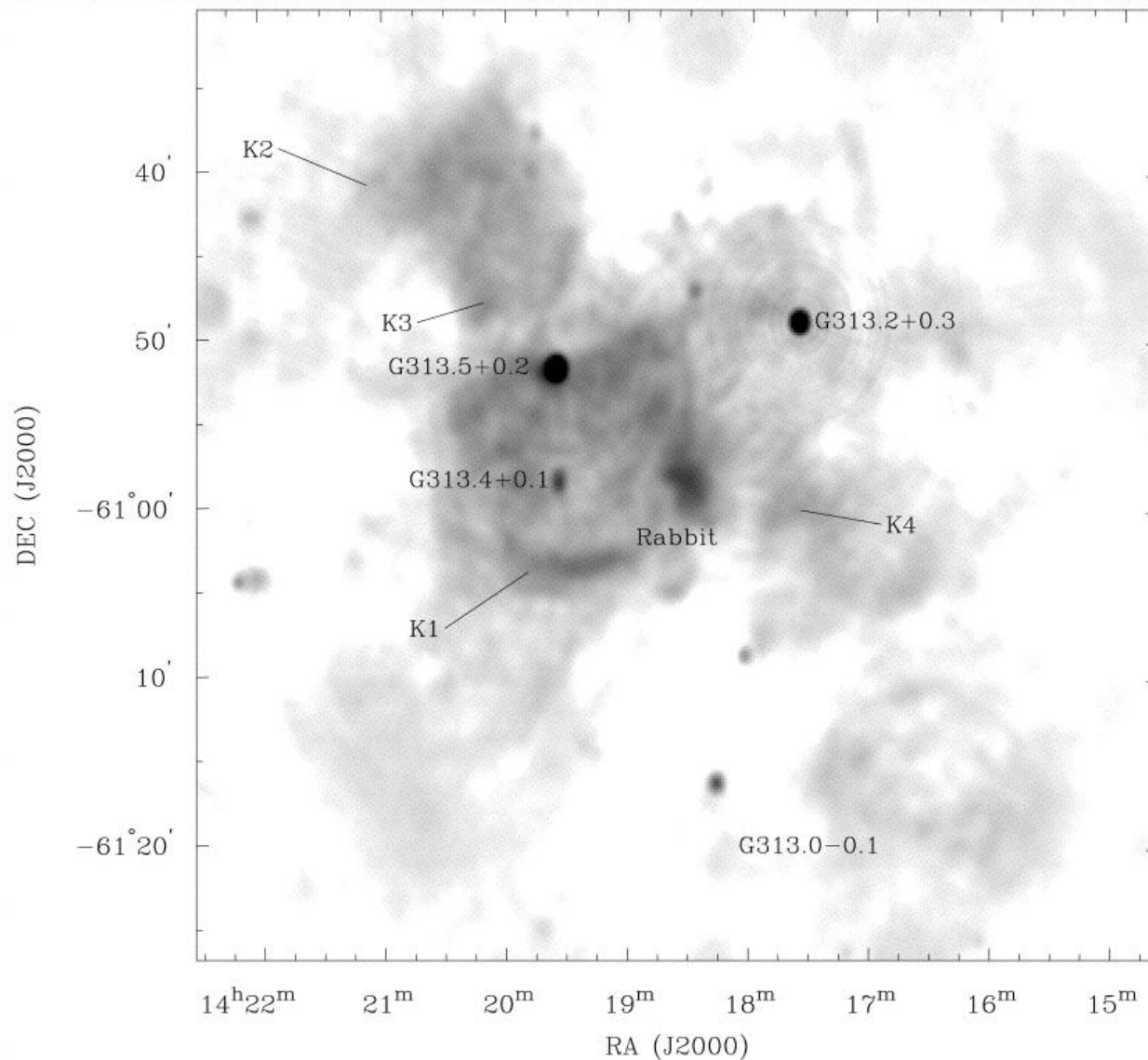


3EG error contours:  
68%, 95%, 99%

Pulsar at K3

Roberts, Romani &  
Kawai (2001)

# Kookaburra

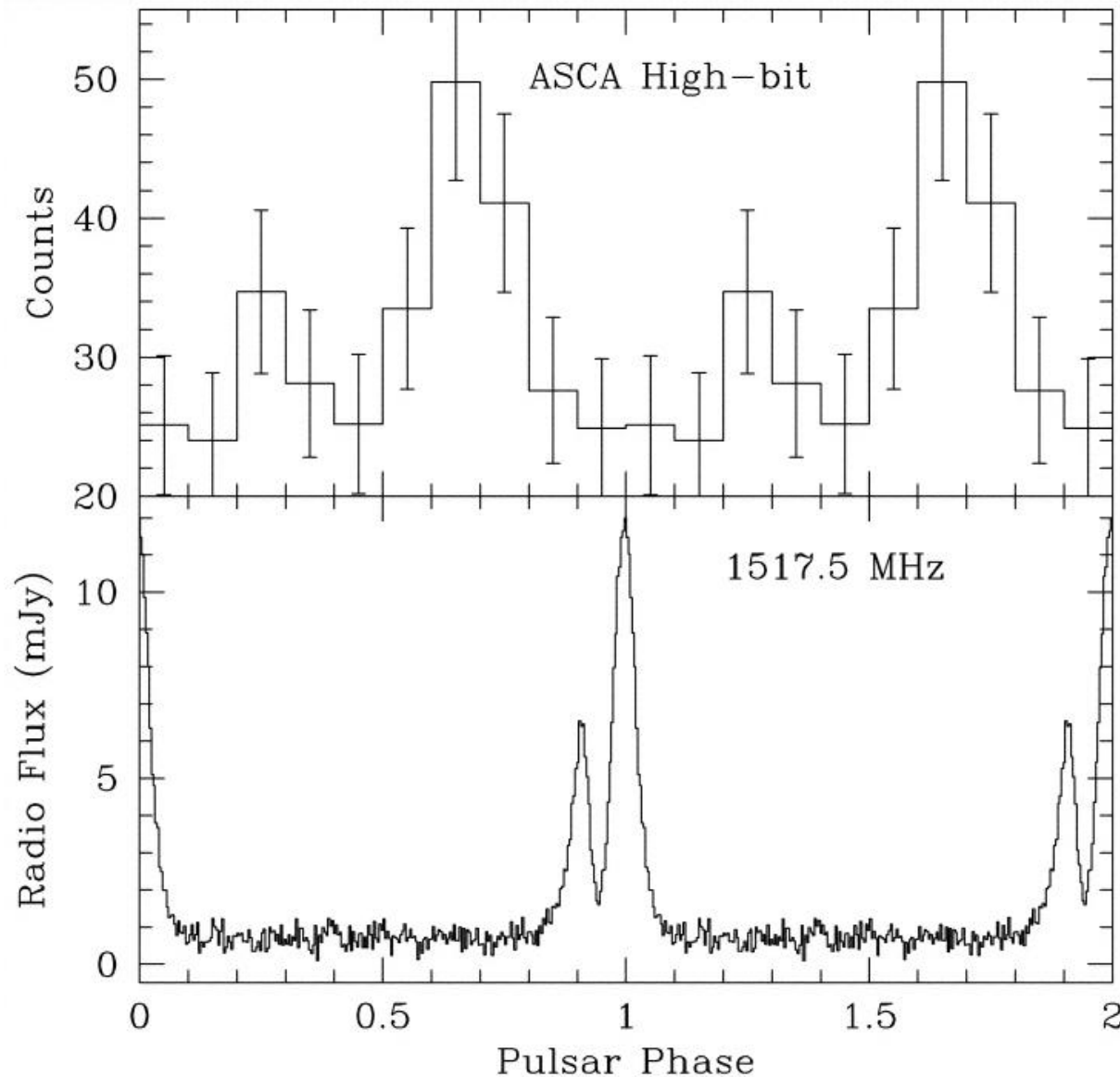


20 cm ATCA  
image of field  
of 3EG J1420-6038

Pulsar at K3  
position.

Roberts et al. (1999)  
suggest Rabbit may  
be 3EG counterpart.

# Evidence for X-ray Pulsations from K3



Possible pulsations support gamma-ray ID as both are likely magnetospheric emission.

Roberts, Romani, Johnston (2001)

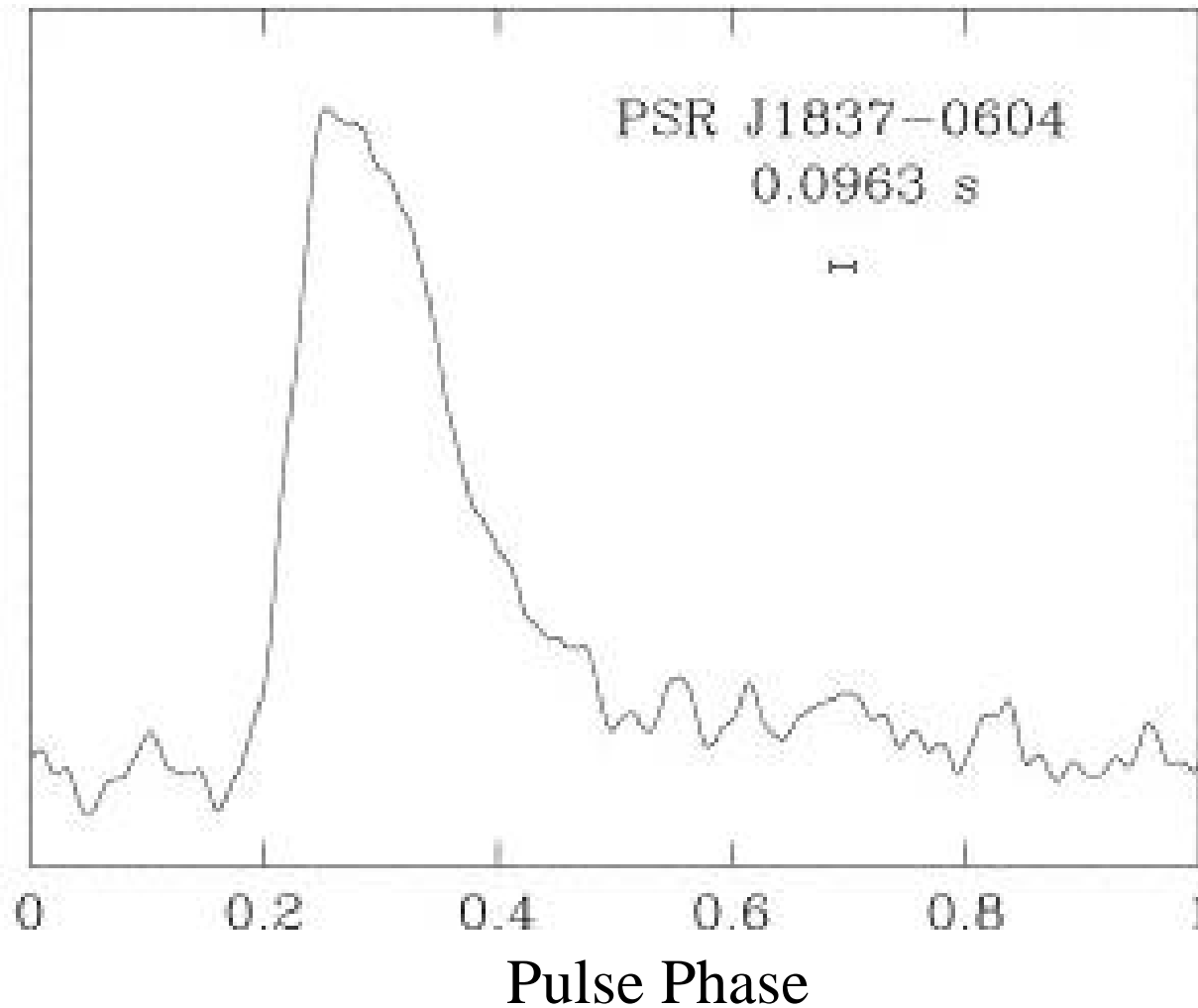


# PSR J1837-0604

- $P = 96 \text{ ms}$ ,  $dP/dt = 45\text{e-}15$
- characteristic age = 34 kyr
- $B = 2.1\text{e}12 \text{ G}$
- $dE/dt = 2\text{e}36 \text{ erg/s}$
- $DM = 462 \text{ pc/cm}^3$ ,  $d = 6.2 \text{ kpc}$
- flux density @ 1400 MHz = 0.4 mJy

D'Amico et al. 2001

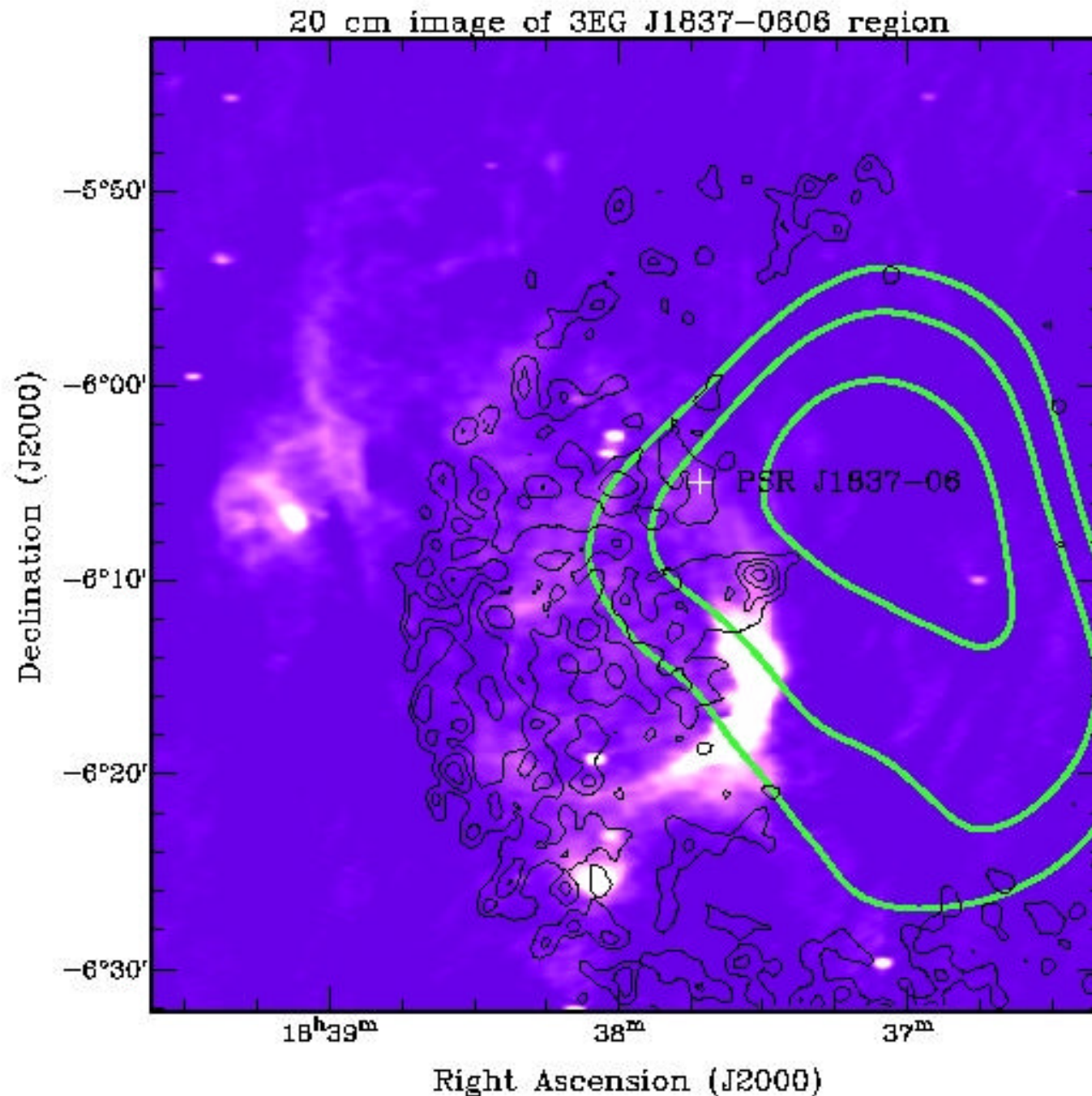
# PSR J1837-0604



Average pulse  
at 1400 MHz

## 3EG J1837-0606

- PSR J1837-0604 is 10' from likeliest 3EG position
- 95% confidence region has radius  $\sim 11'$
- 100 MeV - 10 GeV photon index  $1.82 \pm 0.14$
- flux is  $(3.7 \pm 0.9) \times 10^{-10}$  erg/s/cm<sup>2</sup>
- for  $d=6.2$  kpc and beaming of 1 sr, gamma-ray efficiency is 7%



Black contours:  
ASCA - nothing  
obvious at  
pulsar position  
(CXO also sees  
nothing).

Green contours:  
EGRET 68%,  
95%, 99%

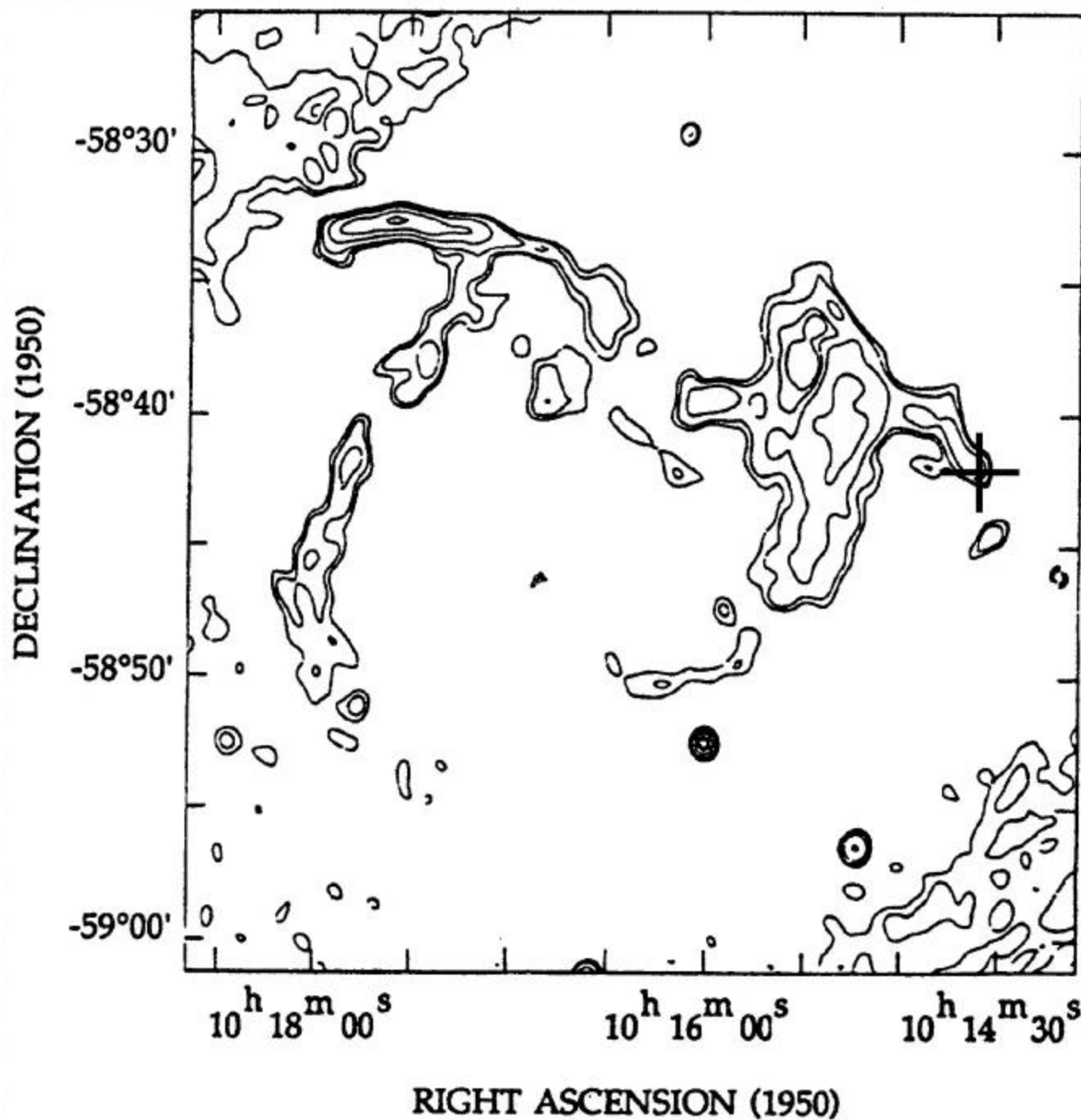
Radio shell is  
probably thermal

Courtesy  
M. Roberts

# PSR J1016-5857

- $P = 107 \text{ ms}$ ,  $dP/dt = 80 \times 10^{-15}$
- characteristic age = 21 kyr
- $B = 3.0 \times 10^{12} \text{ G}$
- $dE/dt = 2.6 \times 10^{36} \text{ erg/s}$
- $DM = 394 \text{ pc/cm}^3$ ,  $d = 9 \text{ kpc}$
- flux density @ 1400 MHz = 0.5 mJy

Camilo et al. 2001

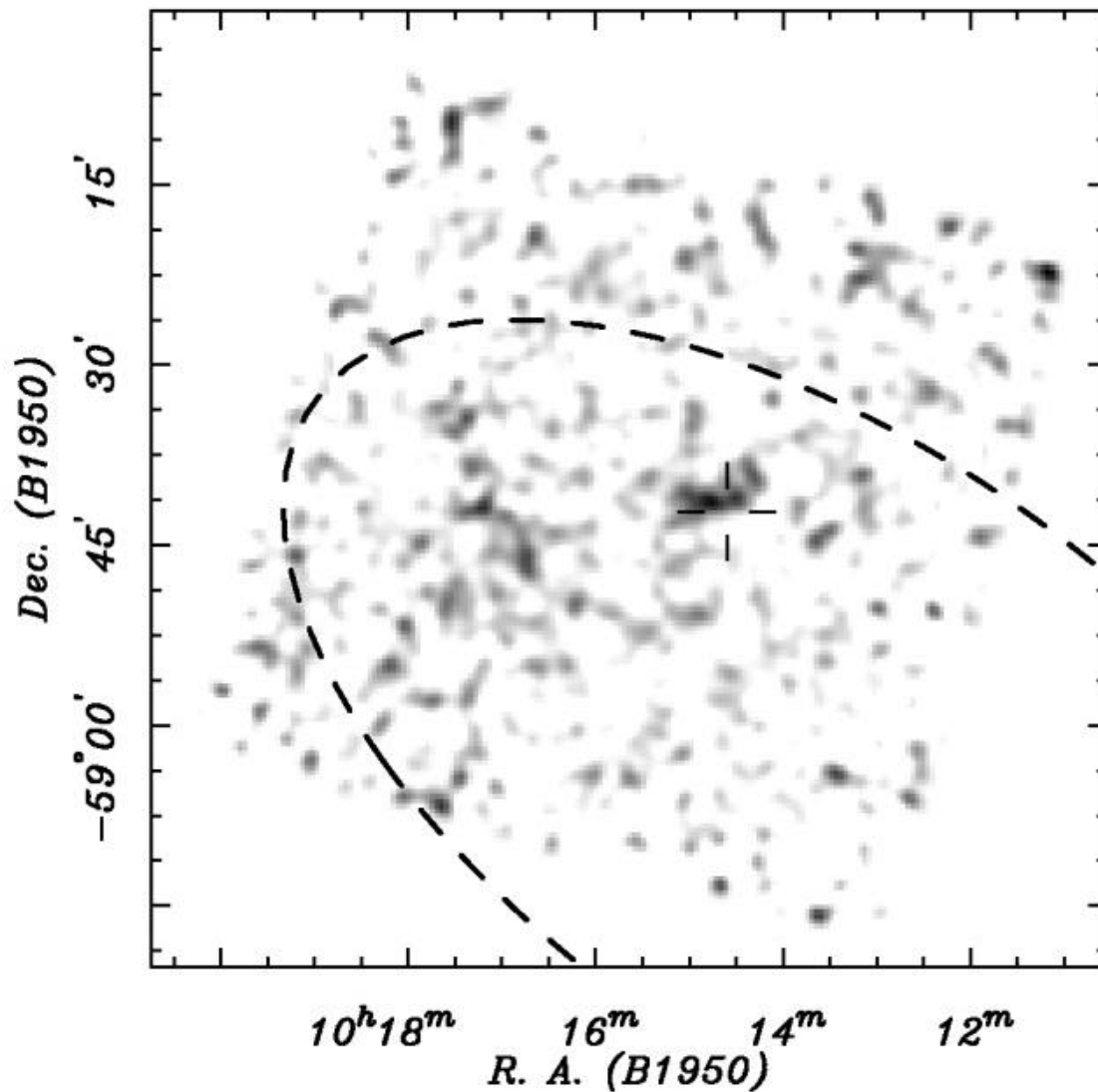


MOST 843 MHz  
image

Ragged shell  
SNR G284.3-1.8  
(Milne et al. 1989)

$d(\text{SNR}) = 3 \text{ kpc}$   
(Ruiz & May 1986)

# Einstein IPC X-ray Image



4.8 sigma X-ray point  
source  $1'.8$  from pulsar

X-ray efficiency 0.05%  
if associated

Dashed ellipse is  
2 sigma error region  
for 3EG J1013-5915

# 3EG J1016-5857

- PSR J1837-0604 well within 2 sigma error box
- 95% confidence region has radius  $\sim 11'$
- 100 MeV - 10 GeV photon index  $2.32 \pm 0.13$
- flux is  $(3.3 \pm 0.6) \times 10^{-10}$  erg/s/cm<sup>2</sup>
- for  $d=3$  kpc and beaming of  $4\pi$  sr, gamma-ray efficiency is 6%
- 3EG source non-variable



# Conclusions

- Parkes survey finding promising EGRET source counterparts
- Each requires multiwavelength studies to help judge possible associations
  - such studies valuable for many reasons: PWN, SNRs...
- GLAST should decide unambiguously through detection of pulsations